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# The Role of Kinds in the Semantics of *Ceteris Paribus* Laws\*

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## 1 Introduction

CP-laws, or better, the cp-statements used to express them, are non-strict, and hence inferentially inert: in the absence of substantial and unobvious background assumptions, cp-statements do not enter into deductively valid inferences concerning their instances.<sup>1</sup> *Ravens are black* implies nothing concerning any individual raven. This inferential inertness animates a great deal of the literature on cp-laws, since it makes it *prima facie* hard to see how the truth of a cp-law is related to the truth of its instances, and how the epistemic status of a cp-law is determined by the evidence available concerning these instances.<sup>2</sup>

CP-statements are inferentially inert when it comes to other cp-statements, too: there are no general patterns of entailment connecting them. For this reason, semantic theories for cp-statements have focused on truth-conditions for cp-statements considered one by one, independently of their deductive relations, and on non-deductive relations among cp-statements, such as probabilification or the underwriting of a default-inference.<sup>3</sup>

In this paper, I take a fresh look at the logic of cp-statements. While there are no fully general entailment patterns involving cp-statements, I will argue that such patterns exist for an interesting subclass of these statements, those that concern kinds.<sup>4</sup> This in turn implies that semantic theories need to treat the two sorts of cp-statements, those concerning kinds and those concerning

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<sup>1</sup>I qualify the claim in the main text by mentioning “substantial and unobvious background assumptions.” Several semantic theories for cp-statements interpret them as restricted universal generalizations (e.g. Hausman, 1992). By adding the premise that an instance falls within the restriction, we *can* draw a valid conclusion. However, such a restriction is substantial and unobvious.

<sup>2</sup>See, e.g., Earman and Roberts (1999); Earman et al. (2002); Lange (2002); Pietroski and Rey (1995).

<sup>3</sup>See, e.g., Spohn (2012).

<sup>4</sup>A terminological note: when I speak of kinds, I do not just have in mind Lewisian perfectly natural properties (cf. Lewis, 1999). As will become clear in the sequel, the distinction between kinds and non-kinds reflected in cp-statements involves a much for liberal understanding of kinds.

non-kinds, separately, which marks a major departure from almost all extant accounts. This result also has an interesting implication for theories of kinds in the special sciences: we cannot explicate the difference between kinds and non-kinds in terms of cp-laws and cp-statements, perhaps by suggesting that a property is a kind if and only if it appears in a cp-law, since our account of the latter must take an account of the former as antecedently understood. I shall illustrate this upshot for the homeostatic property cluster (HPC) conception of kinds.

## 1.1 Generics as CP-Statements

So far, I have identified cp-statements functionally, as statements that express cp-laws. As realizers of this role, I focus on generics rather than (semi-)formal sentences containing the expression *ceteris paribus* or its cognates. Generics are a type of natural language sentence; the generics I focus on are bare plural generalizations, sentences whose subjects are plural noun phrases without any determiners, such as *ravens* in *ravens are black*, *lions* in *lions have four legs*, or *blue-eyed cats* in *blue-eyed cats are usually blind*.

Focusing on generics has at least three benefits. First, generics are used quite generally to state cp-laws and hence map directly onto scientific practice.

1. For animals,  $m = w^{\frac{3}{4}}$ , where  $m$  is the animal's metabolic rate,  $w$  its weight. (Kleiber's Law of ecology)<sup>5</sup>
2. Children are 2-knowers before they are 3-knowers. (Developmental psychology)<sup>6</sup>
3. Kestrels lay five eggs per clutch.<sup>7</sup>
4. During the day, the sea breeze flows from sea to land.<sup>8</sup>

By contrast, the use of the expression *ceteris paribus* is common only in economics, and even there is short of universal.<sup>9</sup>

Second, by focusing on generics, I can draw on the usual tools to distinguish semantic from pragmatic features to help discern inferential patterns.

Finally, focusing on generics naturally imposes divisions within the field of cp-statements, cleaving it into theoretically more manageable chunks. Some generics concern groupings of individuals and samples and ascribe characteristic properties to them. These form one theoretically unified class. Others ascribe dispositions or capacities, which form a distinct theoretical class. In the former class belong the examples I have already mentioned, in the latter

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<sup>5</sup>Cf. West et al. (1997a).

<sup>6</sup>Cf. Carey (2009).

<sup>7</sup>Cf. Stearns and Hoekstra (2000).

<sup>8</sup>Cf. Smith and Pun (2010).

<sup>9</sup>See Schiffer (1991, 10) and Woodward (2002, 305).

generics such as *this iron bar expands when heated*.<sup>10</sup> These can be told apart using straightforwardly semantic means.<sup>11</sup>

Imposing such divisions is a job that any theory of cp-statements must do, since it is widely agreed that the cp-statements as a whole do not form a unified domain. Generics allow us to do so in a way that's largely theory-neutral, and to have fairly clear divisions. To appreciate this, consider an alternative suggestion from Spohn (2002).

“*Ceteris paribus*” = “other things being equal” is obviously a relational condition. [...] Another frequent qualification is that a law holds only in the absence of disturbing influences. Still another way of hedging is to say that a law holds only under normal conditions. A fourth kind are ideal conditions that are assumed by idealized laws though they are known not to obtain strictly.<sup>12</sup>

These distinctions can be hard to apply. *Ravens are black* is perhaps of the third kind, *lions have four legs* is perhaps of the second. *This iron bar expands when heated* might belong to either the second or fourth. I am unsure where *blue-eyed cats are usually blind* would fall.

Note also that the categories are described in terms of the theory they are used to articulate. This is not an objection by itself, since the stipulations are part of the overall theory, and we should judge the theory as a whole. It does mean that by focusing on generics, we have one more point at which to ground the theory in data.

## 2 The Logic of CP-Statements

Consider the examples (5).

- 5. (a) Ravens fly.
- (b) Birds fly.

Both sentences are true. I will argue that this combination of truth-values is not an accident, but represents an entailment of generics concerning kinds, and as such instantiates a general pattern. My argument proceeds in three steps. First (§2.1), I argue that the pattern really is present in full generality, and that this pattern *can* be captured by invoking the distinction between kinds and non-kinds. Second (§2.2), I argue that extant accounts which do not invoke the kind/non-kind distinction are empirically inadequate. Hence, the pattern I

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<sup>10</sup>Hüttemann (this volume) offers a theory of cp-laws in terms of dispositions. The argument I have just made here can be seen as lending further methodological support for treating ascriptions of dispositions as a theoretically viable subgroup of cp-laws. The two kinds of cp-laws do not exhaust the class of generalizations usually captured under the heading of cp-laws. Idealizations are a third (cf. Reutlinger, this volume, for further discussion).

<sup>11</sup>See, e.g., Nickel (in prep).

<sup>12</sup>Spohn (2002, 354). Cf. also Schurz (2002).

describe *should* be captured by invoking the distinction between kinds and non-kinds. Finally (§2.3), I sketch a theoretically well-motivated semantic theory—one I have defended in detail elsewhere—couched in terms of that distinction which accounts for the entailment.

## 2.1 Kinds and Percolation

It is widely and correctly observed that generics *do not* in general allow an inference from subset to superset, as illustrated in (6).<sup>13</sup>

6. (a) Albino ravens are white.  
 $\not\Rightarrow$  b. Ravens are white.

However, there is a more restricted range of generics where the inference from subset to superset is valid. Specifically,

**Kind Percolation** Where the *As* and *Bs* are *kinds*, and the *As* are a subkind of the *Bs*, the following inference is valid.

$$\frac{\text{As are F}}{\therefore \text{Bs are F.}}$$

Informally: characteristic properties of kinds percolate up the taxonomic hierarchy.<sup>14</sup> (5) is an instance of KIND PERCOLATION.

To be clear, I take it as uncontroversial that the examples in (5) are true. The crucial claim is that this combination of truth-values reflects an entailment. One might think this claim obviously false. Consider (7) and (8).

7. Lions give birth to live young.  
8. Platypus lay eggs.

KIND PERCOLATION implies that (7) and (8) entail (9) and (10), respectively.

9. Mammals give birth to live young.  
10. Mammals lay eggs.

And while (9) is certainly unobjectionable, (10) seems clearly false, and hence a counterexample to KIND PERCOLATION. This constellation of examples isn't hard to replicate, either.

11. (a) Ravens fly.  
 $\Rightarrow$  Birds fly.

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<sup>13</sup>For completeness: the inference from superset to subset does not go through either.

<sup>14</sup>I do not intend KIND PERCOLATION to entail that there is a single taxonomic hierarchy. KIND PERCOLATION only holds *if* the kinds involved *do* stand in the relevant relationship.

- (b) Emus run.  
 $\Rightarrow$  (?) Birds run.
- 12. (a) Lions have manes.  
 $\Rightarrow$  (?) Big cats have manes.
- (b) Tigers have stripes.  
 $\Rightarrow$  (?) Big cats have stripes.

I will argue that the unquestioned oddity of these sentences is due not to their being false, for they are true, but to a pragmatic effect: they give rise to a false implicature.

Why think that that they are true? Consider polymorphisms in biology. These are cases in which a population can be divided into disjoint subpopulations. Take the African butterfly *Papilio dardanus* as an example. The males of the species have a single characteristic color which makes them inconspicuous in their natural habitat. The females exhibit multiple patterns, with one pattern resembling the males, while the other patterns are quite conspicuous. These are instances of Batesian mimicry: each closely resembles that of a group of butterflies that resist predation by being unpleasant to eat. Thus, there is an adaptive advantage in being conspicuous for the *Papilio*. Further, there is an adaptive advantage in maintaining multiple coloration patterns, because if all of the conspicuous *Papilio* were to mimic the same danaid, the connection between coloration and bad taste would be weakened in the predator birds, making this an instance of frequency dependent selection.

There is every reason to treat each of the adaptive colors of females as characteristic colors, i.e., to treat all of the sentences in (13) as true.

- 13. (a) *Papilio* are brown.
- (b) *Papilio* are yellow.
- (c) *Papilio* are orange.

Nonetheless, it is odd to say just one of (13a)–(13c) on their own. Doing so gives rise to the impression that the asserted cp-statement is the *whole* truth about the color of *Papilio*, and it is that impression, rather than the cp-statement's actual semantic content, that is clearly false. This diagnosis is supported by performing a standard test for implicatures. We can assert the target sentence while explicitly denying the implicature I claim to be present, as in (14).

- 14. *Papilio* are brown, though I don't mean to imply that it's their only characteristic color.

This removes the implicature, and once the implicature is removed, the sentence is unobjectionable, showing that the oddity of the original is due to that implicature.

With this in mind, return to (10), *mammals lay eggs*. Its infelicity in most contexts stems from the fact that asserting it conveys that egg-laying is the whole truth about reproduction in mammals as an implicature. Just as in the case of *Papilio*, the infelicity is removed when that implicature is cancelled.

15. Mammals lay eggs, though I don't mean to suggest that this is their only or even most common mode of reproduction.

At this point, one may accept that *mammals lay eggs* is true, but maintain that I have changed the topic. I explain. Not all sentences with bare plural subjects predicate characteristic properties of the kind mentioned. Some are simply existential, such as (16).

16. Ravens are sitting on my lawn.

The arguments I have made so far have brought out that sentences like *mammals lays eggs* have an existential flavor to them—one could reasonably paraphrase it as *egg-laying is one of the characteristic modes of reproduction for mammals*. One may take this existential flavor as an indication of a semantic difference between standard cp-statements and the sentences I have been concerned with. The former are near universal, while the latter are existential. Hence, KIND PERCOLATION may still fail for genuine cp-statements.

I agree that *mammals lays eggs* has an existential flavor, but I deny that this makes them semantically distinct from paradigmatic cp-statements like *ravens are black* or any of the examples I quoted at the beginning, (1)–(4). There is no semantic criterion by which these examples can be told apart from the examples I have been discussing most recently.<sup>15</sup> Here, my reliance on generics as data leads to significant theoretical conclusions, since a theorist who starts out with a regimented and stipulated notion of *ceteris paribus*, might take it as a given that cp-statements must have a near-universal character.<sup>16</sup>

Consider now a different but related concern. KIND PERCOLATION seems to imply that higher taxa have very odd, and possibly metaphysically impossible, combinations of properties. Thus (9) and (10) seem to imply that mammals give birth to live young and lay eggs, even though it's impossible for any one mammal to do both. However, this problem is not particular to entailments licensed by KIND PERCOLATION, as (17) shows.

17. (a) Lions have manes.  
 (b) Lions give birth to live young.  
 (c) Lions have manes and give birth to live young.

The first two sentences are uncontroversially true, and they seem to imply the third sentence, without giving rise to a commitment that any individual lion has both a mane and gives birth to live young. So KIND PERCOLATION does not saddle us with impossible commitments, either.<sup>17</sup>

Let me now turn to another sort of potential counterexample, (18).

18. (a) Penguins don't fly.

<sup>15</sup>I defend this claim in detail in other work. See Nickel (2008, 2010).

<sup>16</sup>One particularly clear example of this approach is Schurz (this volume).

<sup>17</sup>It's a further question how to account for this in a systematic semantic theory. See Leslie (2007); Liebesman (2011) for discussion.

- (b) Birds don't fly.

Once again, the first member of the pair is fine, the second objectionable. And in this case, the problem is not that (18b) has a false implicature; note the utter unacceptability of (19).

19. # Birds don't fly, though I don't mean to imply that no sort of bird characteristically flies.

Clearly, (18b) semantically excludes flying from the characteristic modes of locomotion for birds, making it false outright.

At the same time, this observation explains why (18) is not a counterexample to KIND PERCOLATION. (18a) doesn't attribute a characteristic property to the kind penguin. Rather, it says that flight is not among these characteristics. More formally, (18a) has wide-scope (sentential) negation: it is not the case that flight is a characteristic property of penguins. And within the scope of negation, ordinary inferential relations are reversed, so that KIND PERCOLATION does not falsely predict (18a) to entail (18b).<sup>18</sup>

A final objection to KIND PERCOLATION is conceptual. One might object that all truth-evaluable generics concern kinds. This objection can have linguistic or metaphysical grounds. In the linguistics literature, this contention is usually supported by pointing to the contrast between (20a) and (20b).<sup>19</sup>

20. (a) Coke bottles have short necks.  
(b) # Green bottles have short necks.

However, I think that the intuitive contrast between (20a) and (20b) is misdiagnosed. There are many true generics that concern collections we cannot reasonably consider kinds in their own right.

21. (a) Cats with blue eyes are usually blind.  
(b) Whoopee cushions left on the chairs of unsuspecting professors in large seminars are most effective.

Something other than the fact that the green bottles do not form a kind must be responsible for the oddity of (20b).<sup>20</sup>

One may also argue against the existence of true, non-kind-concerning generics on more metaphysical grounds. Consider (22).

22. (a) Albino ravens are white.  
(b) Female tigers give birth to live young.

<sup>18</sup>I develop a semantics that predicts these results in a formally more precise way and motivates them in Nickel (2010).

<sup>19</sup>Cf. Krifka et al. (1995, 11).

<sup>20</sup>Space constraints prevent me from pursuing this point here. For further discussion, see Nickel (in prep, chp. 6).



(c) Immature crimson rosellas are green.

The properties of the collections mentioned in these examples can be investigated inductively, and the members of these collections are causally more or less homogeneous with respect to the properties mentioned. One may conclude that they form kinds just as much as the ravens, tigers, and crimson rosellas.

Against this objection, I want to point out that in the practice of the sciences at issue, in this case, biology, a sharp distinction is usually drawn between a species and partial collections of members of a species, with only the former being taken as forming a theoretically significant unity. Similar remarks apply to non-biological examples. Children form a psychological kind in the context of developmental psychology, but children who grow up in severely stimulus-deprived environments do not.

Of course, this response may strike some as unsatisfactory, since it does not take the form of a theory of natural kinds, showing what more there is to forming a kind beyond being causally homogeneous and inductively investigable. Dialectically, such a demand is misplaced. We're investigating how a distinction between kinds and non-kinds might manifest itself in various aspects of scientific practice. To claim that the examples I've presented as concerning non-kinds in fact concern kinds is to beg the central question.

These considerations make the case that there is a pattern in truth-values among generic sentences that extensionally coincides with the pattern predicted by KIND PERCOLATION. In other words, there is a pattern that *can* be captured by invoking the kind/non-kind distinction. I now turn to two considerations to show that the pattern *should* be so captured.

## 2.2 Extant Alternatives

Most extant semantic theories of cp-statements do not recognize a distinction between cp-statements that concern kinds and cp-statements that concern non-kinds. That includes theories of cp-statements that are otherwise as different from each other as Fodor (1991); Lange (2002); Mitchell (1997, 2000); Pietroski and Rey (1995); Schurz (2001, 2002, 2011); Spohn (2002); Strevens (2012); Woodward (2003).<sup>21</sup> Indeed, the only exception to this near consensus is Lowe (2009). In this subsection, I look at whether these extant accounts offer us the resources to handle the data without invoking the kind/non-kind distinction.

The issue turns on a widely shared commitment, the viability of what I will call the *majority constraint*: it holds that a cp-statement is acceptable only if most members of the kind conform to it.<sup>22</sup>

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<sup>21</sup>This is not to say that these theories hold that any predicate can figure in a cp-statement. As with all laws, the predicates in cp-statements cannot be too gruesome without rendering the statement defective. However, among the viable cp-statements, these theories do not distinguish those that concern kinds and those that do not.

<sup>22</sup>See, for example, Mitchell (1997, 2000); Schurz (2001, 2011); Woodward (2001, 2003) and proponents of the HPC conception (such as Boyd, 1992, 1999; Kornblith, 1993; Wilson et al., 2007). It is also endorsed by Lange (1995, 2000, 2002); Spohn (2002, 2012). An interesting case in this respect is Schrenk (this volume); he does not explicitly discuss how important

A proponent of this constraint agrees with me on some of the data but accounts for them differently while disagreeing with me over others. On this approach, (5a) and (5b)—*ravens fly* and *birds fly*—both happen to be true, though not deductively related. *Birds run*, *mammals lay eggs*, *big cats have manes*, and *big cats have stripes* are all false. The proponent of the majority constraint may well treat this as a point in her favor.

The greatest challenge to the constraint derives from cp-statements that reflect the existence of polymorphisms, since a flat-footed application of the constraint implies that some of these cp-statements must be false. I have argued that these cp-statements are true (though asserting them on their own may be odd in some contexts), and I take this to be a non-negotiable fact about the data. I have also argued that the truth of these statements provides support for my interpretation of the data a proponent of the majority-constraint and I disagree over.

The crucial question for our purposes, then, is whether a proponent of the majority-constraint can account for the data concerning polymorphisms consistently with her treatment of the other data. This question has been discussed in different contexts, and proponents of the majority-constraint have offered three responses: conditional, capacity, and discipline-centered. I'll briefly discuss each, arguing that they all fail. This in turn suggests that alternative treatments of the data fail. KIND PERCOLATION should be accepted.

On the conditional strategy, one re-analyses the polymorphic variants in terms of conditional properties. Consider sexual dimorphism as an example, and specifically, the fact that male dogs have testes.<sup>23</sup> On the conditional strategy, this does not imply that it's characteristic for dogs to have testes. Rather, dogs characteristically *have testes if male*. This property is common to males and females alike, and hence no longer violates the majority constraint. The conditional strategy thus analyzes polymorphisms away, since the population is almost completely uniform with respect to the posited conditional properties. Our ordinary ascriptions of characteristic properties are then simply shorthand, mentioning only the consequent of the conditional property.

Unfortunately, the conditional strategy is also far too permissive.<sup>24</sup> All organisms share the conditional property that if they are cognitively as developed as humans, they have complex social and cultural institutions. This is true of mealworms, for example, and yet there is no sense in which it is characteristic of mealworms that if they are as cognitively developed etc. We would certainly never describe mealworms as having complex social and cultural institutions by way of short-handing the conditional characteristic property, throwing doubt on the characteristicness of that conditional property.<sup>25</sup>

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broad statistical coverage is to assessing any given system of laws, so the view can perhaps be developed to be compatible with the rejection of the majority constraints.

<sup>23</sup>This example is taken from Wilson et al. (2007, 211).

<sup>24</sup>See also Ereshefsky and Matthen (2005); Matthen (2009) for further discussion.

<sup>25</sup>It is of course metaphysically impossible for mealworms to instantiate the antecedent of this conditional. But the proponent of the conditional strategy cannot appeal to this fact in order to block the conclusion that it's characteristic for them that if they are as cognitively

What is more, the conditional strategy threatens to remove an intuitive distinction between polymorphisms and traits that are properly handled using conditional structures. The latter include what are sometimes called “induced responses:” a single genotype can produce different phenotypes depending on environmental conditions, such as producing defensive structures in the presence, and only in the presence, of predators during development, a pattern exhibited by waterfleas of the genus *Daphnia*.<sup>26</sup> It would be better to be able to maintain the distinction between these sorts of traits and polymorphisms.<sup>27</sup> So the conditional strategy for saving a majority constraint fails.

The capacity response has been offered primarily as a means of defending the majority constraint against examples in which, at least at first glance, the majority of members of a kind are aberrations. The most famous example here is (23).

23. Sea-turtles are long-lived.

Most sea-turtles die within hours of hatching, yet (23) is clearly true. Schurz (2001) has suggested that in this case, the property predicated of sea-turtles is not actually that of achieving a long life-span, but of having the capacity to do so. This capacity is shared by most sea-turtles, removing the threat to the majority constraint.

While remaining neutral on this treatment of (23), it seems clear that it cannot be extended to polymorphisms. In no natural sense of capacity do females of a species have the capacity to be male, for example. So the ascription *dogs have testes* cannot be compatible with the majority constraint in virtue of females having the capacity to have testes. Note the contrast to the conditional strategy: there, females posed no problem because they could satisfy the antecedent of “if male, then testes” vacuously, as it were. But the possibility of vacuous satisfaction made the conditional strategy too permissive. The capacity strategy doesn’t allow such vacuous satisfaction, avoiding the mealworm problem, but it is too demanding. So this strategy fails, as well.

Finally, some semantics of cp-statements make the interpretation of these statements sensitive to the disciplinary context in which they are articulated (particularly Lange, 2000, 2002; Woodward, 2003). On this view, cp-statements are true only if they hold in most (perhaps even all) cases *of interest to the discipline*. To take Lange’s example: island biogeography, which articulates the area law, simply ignores the possibility of massive solar radiation killing off all species. But it seems clear that polymorphisms fall squarely within the boundaries of the disciplines that study them. So the discipline-relativity advocated by these theorists cannot be invoked to save the majority constraint on cp-laws, either.

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developed etc. It is also metaphysically impossible for a female to be male, yet that does not stand in the way of her having the conditional property “if male, then having testes.”

<sup>26</sup>Cf. Dodson (1989).

<sup>27</sup>Schurz (2001) draws a similar contrast in a different context between polyphenic traits and genuine polymorphisms.

As the majority constraint falls, so does our best hope of accounting for the distribution of truth-values among cp-statements that does not invoke a kind/non-kind distinction. I therefore conclude that the distribution of truth-values *should* be captured by invoking that distinction.

### 2.3 An Outline of a Sketch of a Positive Account

To complete the defense of KIND PERCOLATION, I sketch a theory that takes the kind/non-kind distinction into account. This simplified account does not generalize easily to logically complex sentences, concerning negation or more complex predicates containing logical operators. To do so, it needs to be supplemented with a detailed description of the LF of generics (the syntactic structure of generics relevant to the compositional semantic interpretation of these sentences), which itself needs to be defended and explained.<sup>28</sup> More complex generics also require further principles concerning the mechanisms that can underwrite the truth of a generic. I present and defend a full semantics that addresses these issues in other work.<sup>29</sup> For the purposes of this discussion, I will confine myself to the simplest generics. At the end of this section, I'll describe the interpretation the semantics yields for a more complex sentence (Kleiber's Law, mentioned earlier) without working through how the semantics predicts this compositionally.

I also want to emphasize that the semantics I sketch here will not address all of the questions a complete theory of cp-statements needs to answer—more on this below. The point of this sketch is only to indicate how the distinction between kinds and non-kinds can be incorporated into a semantic theory.

Several theorists have suggested that cp-laws are closely connected to the existence of mechanisms, where we should think of mechanisms as constellations of events, states, and background conditions.<sup>30</sup> I propose to forge the connection thus.

#### CP-Statements concerning Kinds

*As are F* is true iff

there is a suitable mechanism *m* that operates in at least some *As* and that leads to an *A* being *F* unless the mechanism is distorted or its output altered after the fact.

In this statement of the truth-conditions of cp-statements concerning kinds, I'm treating the cp-statement as not logically articulated, and hence not compositionally, in line with the simplifying assumptions I flagged at the outset. In the

<sup>28</sup> *LF* is meant to be evoke the notion of a *logical form*, though it's a technical notion.

<sup>29</sup> See Nickel (in prep).

<sup>30</sup> See for example the proponents of the HPC conception of kinds mentioned in note 22, along with the new mechanists (e.g. Craver, 2007, 2009; Machamer et al., 2000) and Strevens (2012). In this volume, the contrast between theories of cp-laws that are connected to mechanisms and theories that are not is represented by Pemberton and Cartwright (this volume); Strevens (this volume) on the mechanism side, and Roberts (this volume) on the non-mechanistic side.

fully developed semantics, I posit a covert generic operator in the LF of these sentences that operates roughly like a quantificational determiner.

The substance of the semantics is really the existence of a suitable mechanism: the truth of a cp-statement only depends on its existence. There is no significant statistical constraint. Spelling out this account then requires a theory of suitability, which almost certainly needs to appeal to the explanatory needs, interests, and disciplinary parameters of the researchers articulating the relevant cp-statements. Crucially, such a theory of suitability needs to give substantive, non-generic criteria for what it takes for a mechanism to be *distorted* or *altered* after the fact. It is up to this theory of suitability to tell us in what sense the developmental mechanism associated operative in albino ravens is “distorted” so as to ensure that the existence of that mechanism does not underwrite the truth of *ravens are white*.<sup>31</sup> It is here that my sketched theory will remain a sketch. For my purposes, I’ll take the notion of suitability as primitively understood.

Even given this preliminary sketch, we can already see that these semantics validate KIND PERCOLATION. Suppose that *As are F* is true and that the *As* form a kind. Then there’s a suitable mechanism that operates in at least some *As*, etc. Now suppose that the *Bs* also form a kind, and that the *As* are a subkind of the *Bs*. By the last assumption, every *A* is also a *B*, and hence the suitable mechanism etc. operates in at least some *Bs*. Hence, the truth-conditions of *Bs are F* are satisfied.

Turn now to the semantics for cp-statements concerning non-kinds.<sup>32</sup> If we simply extended the semantics I just pointed to, we would predict that a principle corresponding to KIND PERCOLATION held for non-kinds. Assume that *albino ravens are white* is true. Then the coloration mechanism that operates in albinos must be suitable, and since all albino ravens are ravens, this suitable coloration mechanism that leads to white ravens operates in at least some ravens. Hence *ravens are white* is predicted to be true. This argument obviously generalizes. The semantics for cp-statements concerning non-kinds need to break this argument. Here’s how I propose to do so.

CP-statements concerning non-kinds are also interpreted in terms of mechanisms, but not in terms of *suitable* mechanisms. Instead of identifying the mechanism that underwrites the truth of a non-kind cp-statement in terms of the notion of suitability that appears in the semantics for cp-statements concerning kinds, it’s identified derivatively. Let me give an example.

We need to account for the fact that the coloration mechanism that leads to white albino ravens can underwrite the truth of *albino ravens are white*. We look for a mechanism that is associated with the corresponding kind, the ravens and a characteristic property along the same dimension, in this case, color.<sup>33</sup> This

<sup>31</sup>See, for example, Strevens (2012) and Nickel (in prep).

<sup>32</sup>The notion of a kind-derived subgroup is a metaphysical, not a syntactic one. There are kinds that have syntactically complex names, such as *Common Raven* or *Duckbilled platypus*, and *ice* probably doesn’t form a natural kind on its own, though it is syntactically simple.

<sup>33</sup>Such dimensions are more generally determinables of the property at issue. Having two wings lies along the dimension of having some number of wings. Flying lies along the dimension of means of locomotion.

mechanism is the developmental mechanism issuing in black ravens. We take this mechanism and minimally alter it so that it can operate in members of the kind-derived subgroup, the albinos, which is to say, it now includes the genetic basis for albinism. We then allow the mechanism to proceed as much like the source mechanism as possible, compatibly with its operating in members of the subkind. This is the normal coloration mechanism for albino ravens.

Generalizing yields the following proposal.

### CP-Statements concerning Non-Kinds

Consider the cp-statement about a kind-derived subgroup, *G As are H*, where the group of the *G As* is derived from the kind constituted by the *As*.

There is a mechanism that underwrites the truth of *G As are H* iff  
there is a mechanism *m* such that

- there is a mechanism  $m^*$  that underwrites the truth of a cp-law *As are  $H^*$* , where *H* and  $H^*$  lie along the same dimension, and
- *m* is just like  $m^*$ , compatible with its operating in *G As*,<sup>34</sup> and
- *m* is not interrupted or reversed.

We can immediately see that a principle corresponding to KIND PERCOLATION fails. Crucially, the way we identify a mechanism that can underwrite the truth of a non-kind cp-statement does not imply that such a mechanism is suitable in the sense of the semantics for cp-statements concerning kinds. Purely as a heuristic, assume that a mechanism is suitable iff its presence is the result of an adaptation.<sup>35</sup> Thus, the coloration mechanism leading to black ravens is suitable. But the way we identified the coloration mechanism leading to white albinos, and in virtue of whose existence *albino ravens are white* is true, does not imply that this mechanism is itself the result of an adaptation.

Let me end this section by describing the output the fully developed semantics would yield for Kleiber’s Law, repeated here.

- (1) For animals,  $m = w^{\frac{3}{4}}$ , where *m* is the animal’s metabolic rate, *w* its weight.

I’ll disregard the parenthetical specification of what *m* and *w* stand for. I’ll assume that for the purposes of ecology, the animals form a natural kind.<sup>36</sup> (1) is true iff: there’s a mechanism that operates in at least some animals that

<sup>34</sup>A useful heuristic for evaluating what it takes for  $m^*$  to be just like *m* is this. Begin with *m*, considered as a sequence of causally connected events, states, and background conditions. Do nothing until you need to alter any of the events, states, or background conditions to allow that mechanism to operate in the kind-derived subgroup. Then allow the mechanism to develop further.

<sup>35</sup>This is just an illustrative example. Suitability can take many different forms, even in biological contexts, and certainly beyond

<sup>36</sup>*Nota bene*: I take it that ecology can have its own, proprietary complement of kinds, including the hunters and the prey, the migratory animals, and so on. So while it may be false that the animals as a whole form a natural kind within the context of evolutionary biology—

issues in animals with the Kleiber-ratio, and that mechanism is suitable, given the constraints on suitability imposed by ecology. The sorts of explanations that are currently serious candidates (see, e.g., West et al., 1997b) certainly satisfy this condition.

### 3 HPC and the Priority of Kinds

I have so far argued that a semantic theory for cp-statements needs to have a bifurcated structure: it needs to treat cp-statements concerning kinds and cp-statements concerning non-kinds separately. I finish this discussion by indicating an upshot for a current theory of kinds in the special sciences, the *homeostatic property cluster* (HPC) conception: according to this conception, kinds are defined in terms of cp-laws. Roughly, a collection of objects forms a kind iff they share a suitable mix of properties that are truly predicated of that collection in a cp-law. For example, the ravens form a kind because the ravens share some suitable mix of properties that are truly predicated of them in cp-laws of the form *ravens are F*.

The idea underlying this account of kinds goes back at least to John Stuart Mill. A collection forms a kind because the properties of the members of that collection can be investigated inductively.<sup>37</sup> The HPC account develops this basic idea in two ways. It offers an account of what it means to say that we investigate the properties of members of a kind by induction when we are dealing with collections that aren't completely homogeneous, and it offers a theory of what a suitable mix of properties is, given that not all members of the kind will share all of the properties truly predicated of the kind in a cp-law.<sup>38</sup>

The discussion so far raises a fundamental objection to the architecture of the *hpc* account. It tries to define the notion of a natural kind by appeal to cp-laws; but in order to give a satisfying account of those, it needs to take for granted the very notion of a natural kind. If this argument can be sustained, the circularity I identify spells doom for the prospects of the HPC conception of kinds to fulfill its aspirations.

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they aren't a species, and it may be that only species are kinds (or kind-like individuals) in evolutionary biology—they may still form a kind for the purposes of ecology. If the animals don't form a kind, the treatment I provide in the text applies equally to particular species, and by kind-percolation, the property that characterizes species also applies to animals.

<sup>37</sup>Mill (1891/2002, 95). Cf. Goodman (1983); Quine (1969).

<sup>38</sup>See Wilson et al. (2007) for an excellent exposition.

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